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DEVELOPMENT OF OBJECTIVE 72-HR 0000 GMT CYCLE MAXIMUM TEMPERATURE PREDICTION EQUATIONS FOR THE SUMMER AND FALL SEASONS

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1. INTRODUCTION

Since December of 1976, objective forecasts of the calendar day maximum (max) temperature, approximately 72-hr in advance of 0000 GMT, have been available for use as guidance by National Weather Service (NWS) forecasters (see Dallavalle and Hammons, 1977). Initially, the statistical prediction equations on which this guidance is based were developed only for the winter (December-February) and spring (March-May) seasons. We now also have equations for the summer (June-August) and fall (September-November) seasons. All the equations were derived by using the Model Output Statistics (MOS) technique (Glahn and Lowry, 1972).

2. DEVELOPMENT

We had four years (1973-76) of developmental data for both the summer and fall seasons. This amounted to slightly over 300 cases during each season. For predictors, we screened various forecast fields from the Primitive Equation (PE) model (Shuman and Hovermale, 1968) that were interpolated to each station of interest (see Table 1). We also screened the first and second harmonics of the day of the year. We used the same list of potential predictors in the development of our spring 72-hr forecast equations (Dallavalle and Hammons, 1977). The predictand was the calendar day max observed approximately 72 hr after 0000 GMT (i.e., the day after tomorrow's max). As in the previous effort, we developed these 72-hr max temperature equations for only 226 of the usual 228 MOS max/min forecast stations (National Weather Service, 1977). This was because sufficient predictand data were not available for Dallas (DAL), Texas and Zuni (ZUN), New Mexico.

3. RESULTS

For the developmental data, the average standard error of estimate of the 72-hr summer season equations was 4.4°F. Individual standard errors ranged from 1.5°F at Key West, Florida to 6.7°F at Missoula, Montana. The average reduction in variance for all stations combined was 54%.

The average standard error of estimate was 5.5°F for the fall equations and ranged from 1.8°F at Key West, Florida to 8.3°F at Dodge City, Kansas. The overall average reduction of variance was 82%.

Figure 1 shows the summer and fall season standard errors for our complete set of 0000 GMT cycle max/min equations (i.e., projections of approximately 24-, 36-, 48-, 60-, and 72-hr). The standard errors for the fall season are higher at all projections than the standard errors for the summer. This may be the result of the greater variability of temperature in the fall. In general, the errors for the 72-hr equations continue the trends established by the equations for the shorter projections.

The most important predictors in both seasons, judged on the basis of their frequency and order of selection in the 10-term equations, are given in Table 2. Here, we see that low-level temperature, humidity, and wind forecasts are critical predictors in the temperature forecast equations. The cosine day of the year is the most important predictor during the fall season. We also found this to be the case for the spring season (Hammons, et al., 1976). During the transitional seasons (spring and fall), the cosine is well correlated (inversely) with seasonal fluctuations in temperature.

4. FUTURE WORK

There are now 72-hr maximum temperature forecast equations available for all four seasons. We plan to verify the operational forecasts generated by these equations. We also hope to make comparisons with climatology and persistence, and eventually use this information to derive 84-hr and 96-hr forecast equations from 0000 GMT cycle data.

5. REFERENCES

Dallavalle, J. P. and G. A. Hammons, 1977: Testing and implementation of MOS max/min forecast equations derived from extended range PE fields. TDL Office Note 77-4, 12 pp.

Glahn, H. R., and D. A. Lowry, 1972: The use of model output statistics (MOS) in objective weather forecasting. J. Appl. Meteor., 11, 1203-1211.

Hammons, G. A., J. P. Dallavalle, and W. H. Klein, 1976: Automated temperature guidance based on three-month seasons. Mon. Wea. Rev., 104, 1557-1564.

National Weather Service, 1977: Stations in FOUS bulletins. NWS Tech. Proc. Bull., No. 200, 14 pp.

Shuman, F. G., and J. B. Hovermale, 1968: An operational six-layer primitive equation model. J. Appl. Meteor., 7, 525-547.

Table 1. Potential predictors of the 72-hr maximum surface temperature for MOS screening regression. The valid times of the forecasts are in hours after 0000 GMT. Stars indicate the predictor was smoothed by a 5-point (*) or 9-point (**) space filter.

Predictor	Projection (Hr after 0000 GMT)
a) PE Model	
850-mb height	60,72*
500-mb height	60,72*
500-1000 mb thickness	60,72*,84*
850-1000 mb thickness	60,72*,84*
500-850 mb thickness	60,72*,84*
1000-mb temperature	60**,72**,84**
850-mb temperature	60**,72**,84**
700-mb temperature	60**,72**,84**
Boundary layer potential temperature	60**,72**,84**
Boundary layer U wind	60*,72*,84*
Boundary layer V wind	60*,72*,84*
Boundary layer wind speed	72*
Boundary layer vertical velocity	72**
850-mb U wind	60*,72*,84*
850-mb V wind	60*,72*,84*
1000-mb relative vorticity	72**
850-mb relative vorticity	72**
500-mb relative vorticity	72**
850-mb vertical velocity	72**
650-mb vertical velocity	72**
700-1000 mb temperature	60**,72**,84**
500-850 mb temperature	60**,72**,84**
490-1000 mb mean relative humidity	60**,72**,84**
Precipitable water	60**,72**,84**
Boundary layer wind divergence	60**,72**,84**
Boundary layer relative humidity	60**,72**,84**
Layer 1 (top of B.L.-720 mb) rel. humidity	60**,72**,84**
Layer 2 (720 mb-490 mb) relative humidity	60**,72**,84**
850-mb temperature advection	60**,72**,84**
500-mb geostrophic vorticity advection	60**,72**,84**
b) Other variables	
Sine day of year	0
Cosine day of year	0
Sine twice day of year	0
Cosine twice day of year	0

Table 2. The ten most important predictors in the 72-hr maximum temperature equations for the summer (a) and fall (b) seasons. The predictors were ranked on the basis of a weighted scoring system that emphasized both the frequency and order of selection of individual predictors. All model predictors were from the PE model.

Order	Predictor
	a) Summer Equations
1	Boundary layer U wind
2	500-1000 mb thickness
3	850-mb temperature
4	Boundary layer relative humidity
5	500-mb height
6	850-1000 mb thickness
7	850-mb temperature advection
8	850-mb U wind
9	Layer 1 relative humidity
10	Boundary layer wind divergence
	b) Fall Equations
1	Cosine day of year
2	850-mb temperature
3	850-1000 mb thickness
4	850-mb temperature advection
5	Boundary layer relative humidity
6	1000-mb temperature
7	Boundary layer potential temp
8	Boundary layer U wind
9	500-mb geostrophic vorticity advection
10	850-mb V wind

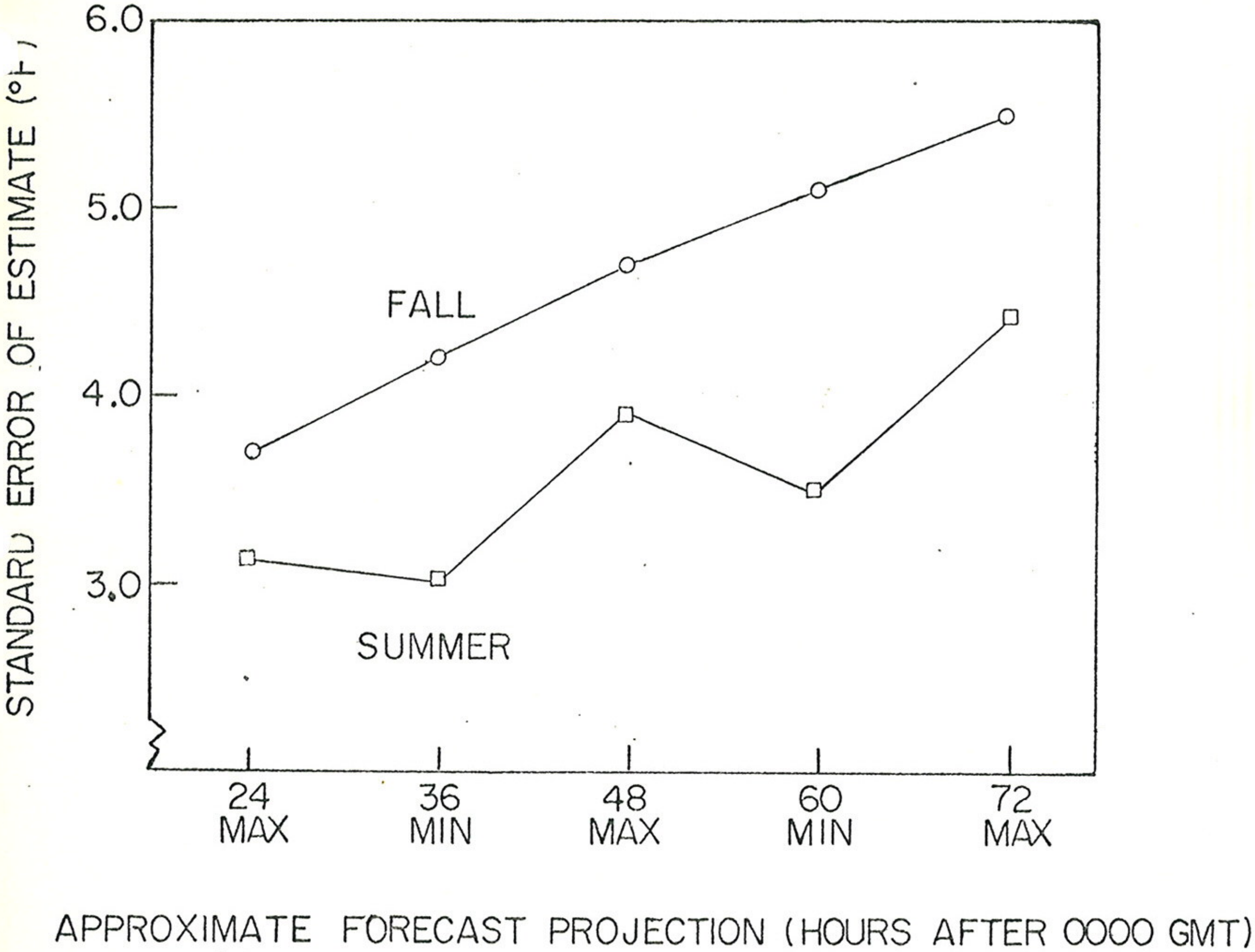

Figure 1. Comparison of the standard errors of estimate averaged for approximately 228 stations in the conterminous U.S. for summer and fall season 0000 GMT cycle max/min temperature prediction equations.